ORGANIC COMPOUNDS

British Patent Application No. 9828710.5

This invention relates to biologically active compounds and to their use in the treatment and prophylaxis of disease. In particular the invention relates to compounds which affect the stability of mRNA which contain one or more mRNA instability sequences.

Recently, it has become increasingly apparent that the regulation of RNA half-life plays a critical role in the tight control of gene expression and that mRNA degradation is a highly controlled process. RNA instability allows for rapid up- or down-regulation of mRNA transcript levels upon changes in transcription rates. A number of critical cellular factors, e.g. transcription factors such as c-myc, or gene products which are involved in the host immune response such as cytokines, are required to be present only transiently to perform their normal functions. Transient stabilisation of the mRNAs which code for these factors permits accumulation and translation of these messages to express the desired cellular factors when required; whereas, under non-stabilised, normal conditions the rapid turnover rates of these mRNAs effectively limit and "switch off" expression of the cellular factors. However, abnormal regulation of mRNA stabilisation can lead to unwanted build up of cellular factors leading to undesirable cell transformation, e.g. tumour formation, or inappropriate and tissue damaging inflammatory responses.

Although the mechanisms which control mRNA stability are far from understood, sequence regions have been identified in a number of mRNAs, which appear to confer instability on the mRNAs which contain them. These sequence regions are referred to herein as "mRNA instability sequences". For example, typical mRNA instability sequences are the AREs (AU rich elements), which are found in the 3'UTR (3' untranslated region) of certain genes including a number of immediate early genes and genes coding for inflammatory cytokines, e.g. IL-1β and TNFα.

Kastelic et al. (CYTOKINE, Vol. 8, No. 10, (October), 1996: pp751-761) have reported the finding that radicicol analog A, if added to THP-1 cells activated by IFN-γ and LPS, not only inhibited the secretion of IL-1β but also induced an extremely rapid degradation of IL-1β, IL-6 and TNF-α mRNA to undetectable levels in 5-8 h, and that this mRNA degradation appears to be

mediated through AU-rich regions present in the 3' untranslated regions of the RNAs which code for these cytokines.

Previously, novel Radicicol analogs (including radicicol analog A), processes for their preparation and their pharmaceutical use were described in European patent application EP 0606044 A, together with known compounds including radicicol, O-methyl radicicol, and the related compound zearelenone and certain analogs of zearelenone. The radicicol analogs and known compounds are described in EP 0606044 A to be useful for the treatment of disorders with an etiology associated with or comprising excessive cytokine release, particularly IL-1β release, such as rheumatoid arthritis, osteoarthritis, septic shock, psoriasis, atherosclerosis, inflammatory bowel disease, Crohn's disease and asthma.

We have now found that there are other compounds in addition to radicicol analog A which induce degradation of mRNAs and that such compounds may be used for treatment of diseases and medical conditions which involve increased or prolonged stability and expression of such mRNAs. Moreover we have found that radicicol analog A may be used generally to induce degradation of mRNAs besides IL-1β, IL-6 and TNF-α mRNAs.

Accordingly the present invention provides a compound which induces degradation of mRNA which contains one or more mRNA instability sequences for use as a pharmaceutical, provided the compound is not a radicicol analog.

In a further aspect the invention provides a method for the prophylaxis or treatment of a disease or medical condition having an etiology associated with the increased stability of mRNA which contains one or more mRNA instability sequences, comprising administering to a human or animal patient an effective amount of a compound which induces degradation of the mRNA, provided that the compound is not a radicicol analog when the disease or medical condition is one with an etiology associated with or comprising excessive cytokine release, particularly IL-1β release, such as rheumatoid arthritis, osteoarthritis, septic shock, psoriasis, atherosclerosis, inflammatory bowel disease, Crohn's disease and asthma.

In a yet further aspect the invention provides use of a compound which induces degradation of mRNA which contains one or more mRNA instability sequences, for the preparation of a medicament for use in the treatment or prophylaxis of a disease or medical condition having an etiology associated with the increased stability of mRNA which contains one or more mRNA instability sequences, provided that the compound is not a radicicol analog when the disease or medical condition is one with an etiology associated with or comprising excessive cytokine release, particularly IL-1β release, such as rheumatoid arthritis, osteoarthritis, septic shock, psoriasis, atherosclerosis, inflammatory bowel disease, Crohn's disease and asthma.

The invention also provides a method for inducing degradation of mRNA in a patient, which comprises administering an effective amount of a compound which induces mRNA degradation to the patient, wherein the mRNA contains an mRNA instability sequence, provided that the compound is not radicicol analog A when the mRNA is mRNA coding for IL-1β, IL–6 or TNF-α.

Further the invention provides use of a compound which induces mRNA degradation in the preparation of a medicament for use in inducing degradation of mRNA which contains a mRNA degradation sequence in a patient, provided that the compound is not radicicol analog A when the mRNA is mRNA coding for IL-1β, IL–6 or TNF-α.

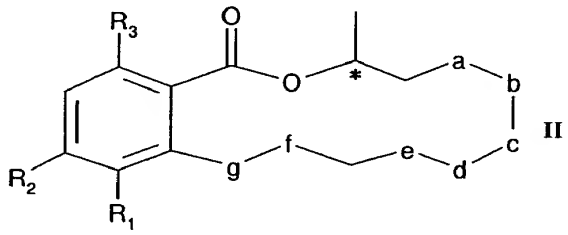
Any compound which induces degradation of mRNA which contains a mRNA instability sequence is potentially of interest for use in the present invention. Compounds which induce degradation of mRNA which contains a mRNA instability sequence are hereinafter referred to as Compounds for use in the invention. Such compounds include radicicol analogs, in particular radicicol analog A or radicicol; for instance, as described in EP 0606044 A, or as described and defined in our copending British patent application of even date herewith, entitled "PHARMACEUTICAL USES".

Our copending British patent application of even date herewith, entitled "ASSAY", describes a reporter gene assay for the identification of compounds which destabilise mRNA. In this assay test compounds are contacted with a DNA expression system which in the absence of the compound is capable of expressing a protein having a detectable signal, and wherein the mRNA which codes for the protein and which is transcribed from the expression system comprises at least one copy of a

mRNA instability sequence. The detectable signal is measured in the presence of the test compound and the result obtained is compared with a control. Compounds which destabilise mRNAs induce degradation of the mRNA which codes for the detectable signal leading to a decrease in the magnitude of the detectable signal obtained in the reporter gene assay.

Preferred compounds for use in the present invention include compounds which may be identified as inducers of mRNA instability using the reporter gene assay as described above and as described in more detail in the above mentioned "ASSAY" patent application and as hereinafter described in the Examples. Particular examples of compounds for use in the present invention include radicicol and the radicicol analogs.

A particular class of radicicol analogs which includes Compounds for use in the invention are compounds of formula II



II

wherein

R_1 is H, OH, halogen, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-;

R_2 is OH, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-;

R_3 is H, OH, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-;

-a-b- is $-CHR_7-CHR_8-$ or cis or trans $-CR_7=CR_8-$,

wherein R_7 and R_8 are the same or different and are H, OH, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-, or

-a-b- is $-CHR_7-CHR_8-$ and R_7 and R_8 together with O form an epoxide bridge;

c is >CH-OH, >C=O or $>CH_2$;

-d-e- is $-CHR_7-CHR_8-$ or cis or trans $-CR_7=CR_8-$,

wherein R_7 and R_8 are the same or different and are H, OH, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-, and

-f-g- is $-CH_2-CH_2-$, cis or trans -CH=CH-, or $-C(O)-CH_2-$,

and pharmaceutically acceptable salts thereof and physiologically-hydrolysable and -acceptable esters thereof.

The carbon atom marked with an asterisk (*) in formula II is an asymmetric carbon atom. The carbon atoms at a, b, c or d may also be asymmetric carbon atoms dependent upon the particular substituents present at these positions. Asymmetric carbon atoms at these positions may have the R- or S-configuration or the radicicol analog may comprise any mixture of the optical isomers thereof. Preferred isomers include those specifically described hereinafter.

Halogen or halo as used herein refers to F, Cl, Br or I unless otherwise indicated, preferably Cl.

A particular subset of the compounds of formula II are those in which one of -a-b- or -d-e- is $-CHR_7-CHR_8-$ and the other is cis- or trans- $-CR_7=CR_8-$, wherein R_7 and R_8 are the same or different and are H, OH, C_1-C_4 lower alkoxy, or C_1-C_4 lower alkyl-COO-, and c is >CH-OH or >C=O, and wherein R_1, R_2, R_3 and -f-g- are as defined above.

Particular significances for the variable substituents and moieties of the radicicol analogs of formula II are as follows:

Preferably R_1 and R_3 are the same or different and are H, -OH, MeO- or Me-COO-. Preferably R_2 is -OH, MeO- or MeCOO-. More preferably R_1 is H or MeO; R_2 is MeO, and R_3 is OH or MeO.

Preferably -a-b- is cis- or trans- $-CR_7'=CR_8'-$, wherein R_7' and R_8' are the same or different and are H, OH, MeO- or Me-COO-. More preferably -a-b- is cis- or especially trans- -CH=CH-.

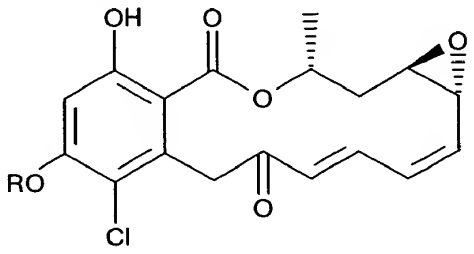
Preferably -d-e- is $-CHR_7'-CHR_8'-$, wherein R_7' and R_8' are as defined above. More preferably -d-e- is $-CH_2-CH_2-$ or especially -CHOH-CHOH-, wherein the OH groups may be in free or protected form.

Most preferably -f-g- is trans- -CH=CH-.

Preferably the asymmetric carbon atoms of the compounds of the invention all have the S-configuration.

Particular radicicol analogs of formula II for use in the invention are analogs of formula II in which R_1 is H or methoxy, R_2 is methoxy, R_3 is OH, -a-b- is cis- or trans- -CH=CH-, c is CHOH or C=O, -d-e- is -CHOH-CHOH- and -f-g- is trans- -CH=CH-; in free form or base salt form or in the form of a physiologically-hydrolysable and -acceptable ester.

Particular radicicol analogs for use in the present invention include radicicol and O-lower alkyl radicicols, i.e. the compounds of formula I'



I'

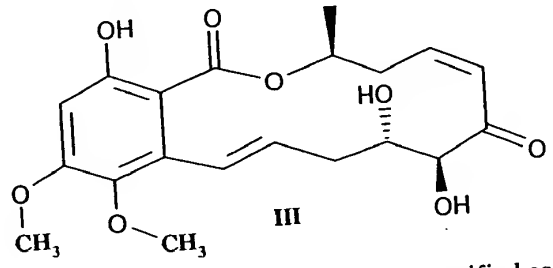
where R is H or C_1-C_4 lower alkyl, e.g. methyl, and pharmaceutically acceptable salts thereof and physiologically-hydrolysable and -acceptable esters thereof.

Radicicol analogs which comprise -OH substituents may also exist in the form of pharmaceutically acceptable esters, and the use of such is included within the scope of the invention. Pharmaceutically acceptable esters are preferably prodrug ester derivatives, such being convertible by solvolysis or under physiological conditions to the free radicicol analog. Preferred pharmaceutically acceptable prodrug esters of the are those derived from a carboxylic acid, a carbonic acid monoester or a carbamic acid, advantageously esters derived from an optionally substituted lower alkanoic acid or an arylcarboxylic acid.

Radicicol analogs may also exist in the form of pharmaceutically acceptable salts, and the use of such is included within the scope of the invention. Pharmaceutically acceptable salts represent acid addition salts with conventional acids, for example, mineral acids, e.g., hydrochloric acid, sulfuric or phosphoric acid, or organic acids, for example, aliphatic or aromatic carboxylic or sulfonic acids, e.g., acetic, propionic, succinic, glycolic, lactic, malic, tartaric, citric, ascorbic, maleic, fumaric, hydroxymaleic, pyruvic, pamoic, methanesulfonic, toluenesulfonic, naphthalenesulfonic, sulfanilic or cyclohexylsulfamic acid; also amino acids, such as arginine and lysine. For compounds of the invention having acidic groups, for example, an acidic -OH group,

pharmaceutically acceptable salts also represent metal or ammonium salts, such as alkali metal or alkaline earth metal salts, e.g., sodium, potassium, magnesium or calcium salts.

EP 0606044 A describes the isolation and characterisation of the radicicol analog of formula III,



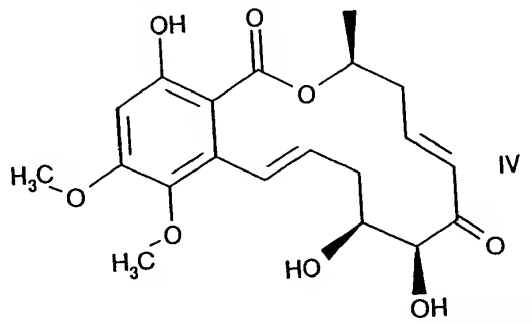
III

hereinafter referred to as radicicol analog A, which was first identified as a natural product isolated from a strain of pycnidia imperfect fungi (F/87-250904) deposited on 6 November 1991 with the ARS Patent Culture Collection, US Dept. of Agriculture, Northern Regional Research Centre, Peoria, Illinois, USA under the provisions of the Budapest Treaty as deposit NRRL 18919.

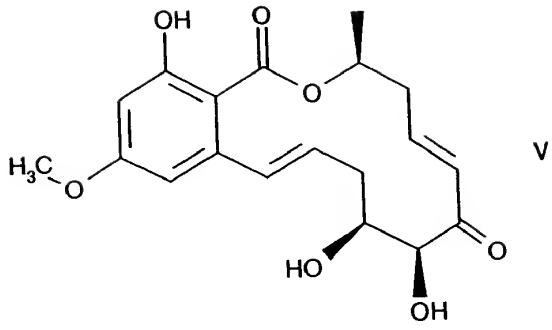
Radicicol analog A is a particularly preferred radicicol analog for use in the present invention. Radicicol analog A also serves as a valuable starting material for synthesis of other radicicol analogs for use in the present invention. Alternatively EP 0606044 A describes the de novo synthesis of radicicol analogs starting from readily available starting materials.

The disclosure of EP 0606044 relating to the isolation of radicicol analog A from the fungal strain F/87-250904, the synthesis of semi-synthetic radicicol analogs from radicicol analog A and the de novo synthesis of radicicol analogs, is specifically incorporated by reference in the teaching of the present application.

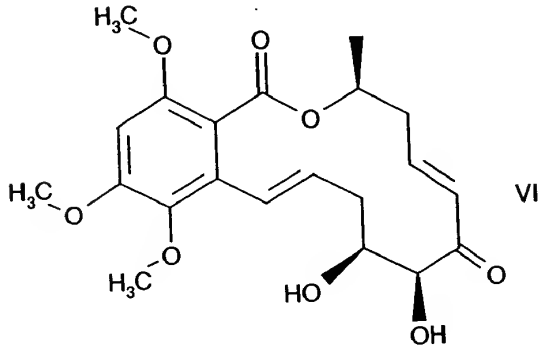
Particularly preferred radicicol analogs for use in the invention include compounds of formula II in which -a-b- is <u>trans</u>- -CH=CH-, e.g. the compounds of formulae IV, V and VI



IV

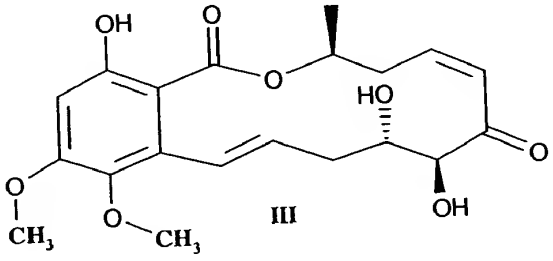


V

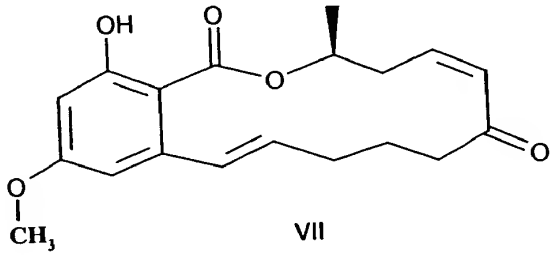


VI

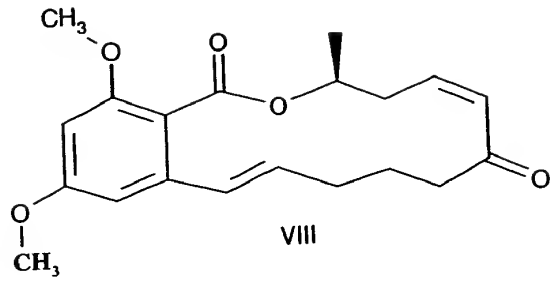
Particularly preferred radicicol analogs for use in the invention include compounds of formula II in which -a-b- is trans- -CH=CH-, e.g. the compounds of formulae III, VII and VIII.



III



VII



VIII

The present invention may be used in the prophylaxis or treatment of diseases and medical conditions in general having an etiology associated with the increased or prolonged stability of mRNAs which contain one or more mRNA instability sequences, and which on prolonged or inappropriate expression typically give rise to undesirable effects, e.g. cancer cell growth or an unwanted inflammatory response.

mRNA instability sequences have been identified in the UTRs, in particular the 3' UTRs, of a large number of transiently expressed genes including genes for cytokines, chemokines, nuclear transcription factors, protooncogenes, immediate early genes, cell cycle controlling genes, oxygenases, and genes involved in and controlling of apoptosis. The natural RNA sequences which comprise the mRNA instability sequences are alternatively referred to as adenylate/uridylate (AU)-rich elements, or AREs. Transiently expressed genes which contain mRNA instability sequences include, for example, the genes coding for GM-CSF, c-*fos*, c-*myc*, c-*jun*, *krox*-20, *nur*-77, *zif268*, β-IFN, uPA, IL-1, IL-3, TNF-α, MCP1, syn1, β_2-AR, E-selectin, VCAM-1, ICAM-1, P-glycoproteins (MDR), MRPs, Pγh1 (pf mdr), COX II, metalloproteinases (MMPs), bcl-2 and MIP-2α.

The following publications include extensive discussion of mRNA instability sequences and AREs, the sequences motifs which they contain and (minimum) sequence requirements for mRNA destabilisation, as well as identifying a number of mRNA instability sequences and the genes which contain them:

Shaw & Kamen, Cell, Vol. 46, 659-667, August 29 1986 (GM-CSF);

Shyu et al., Genes & Development, 5:221-231 (1991) (c-*fos*);

Sachs, Cell, Vol. 74, 413-421, August 13 1993 (Review. "Messenger RNA Degradation in Eukaryotes");

Chen et al., Mol. Cell. Biol., Jan 1994, p 416-426 (c-*fos*);

Akashi et al., Blood, Vol. 83, No. 11, (June 1), 1994: pp 3182-3187 (GM-CSF etc.);

Nanbu et al., Mol. Cell. Biol., July 1994, p. 4920-4920 (Upa);

Stoecklin et al., J. Biol. Chem., Vol. 269, No. 46, November 18 1994, pp 28591-28597 (IL-3);

Lagnado et al., Mol. Cell. Biol., Dec. 1994, p. 7984-7995 (general);

Zhang et al., Mol. Cell. Biol., Apr. 1995, p. 2231-2244 (yeast);

Zubiaga et al., Mol. Cell. Biol., Apr. 1995, p. 2219-2230 (general);

Winstall et al., Mol. Cell. Biol., July 1995, p. 3796-3804 (c-*fos*, GM-CSF);

Chen et al., Mol. Cell. Biol., Oct. 1995, p. 5777-5788 (c-*fos*, GM-CSF);

Chen et al., TIBS 20 November 1995, 465-470 (review);

Levy et al., J. Biol. Chem., Vol. 271, No. %, February 2 1996, pp. 2746-2753 (VEGF);

Kastelic et al., Cytokine, Vol. 8, No. 10 (October), 1996: pp751-761;

Crawford et al., J. Biol. Chem., Vol. 272, No. 34, August 22 1997, pp. 21120-21127 (TNF-α);

Xu et al., Mol. Cell. Biol., Aug. 1997, Vol. 18, No. 8, p. 4611-4621 (general);

Danner et al., J. Biol. Chem., Vol.273, No. 6, February 6 1998, pp. 3223-3229 (human β_2-Adrenergic Receptor);

Lewis et al., J. Biol. Chem., Vol. 273, No. 22, May 29 1998, pp. 13781-13786 (TNF-α).

As described in the above publications mRNA instability sequences often contain one or more copies of sequence motifs, e.g. selected from: AUUUA, UAUUUAU, UUAUUUA(U/A)(U/A)

, and

AUUUAUUUA. Such sequence motifs are typically in genes between the stop codon and the poly A signal and may associated with appropriate flanking sequences and may interact in combination with other sequences, e.g. present in the 5' UTR and e.g. with instability motifs present in the coding region.

The present invention may be used in connection with diseases and medical conditions associated with any of the genes mentioned above or described in the listed publications, which comprise mRNA instability sequences.

Examples of diseases and medical conditions which may be treated or prevented by use of the present invention include: cancers e.g. of the colon, breast, lung etc., acute and chronic

inflammation, autoimmune diseases, respiratory diseases, infectious diseases and transplant rejection.

Compounds for use in the Invention can be used both alone and in combination with other pharmacologically active compounds, for example in cancer treatment the compounds may be used together with inhibitors of the enzymes of polyamine synthesis, inhibitors of protein kinase C, inhibitors of other tyrosine kinases, cytokines, negative growth regulators, for example TGF-ß or IFN-ß, aromatase inhibitors, antioestrogens and/or cytostatic agents.

Suitable pharmaceutical compositions comprising Compounds for use in the invention as active ingredient and that can be used especially in the treatment of the diseases mentioned above include compositions for enteral, such as nasal, buccal, rectal or especially oral, administration and parenteral, such as intravenous, intramuscular or subcutaneous, administration to warm-blooded animals, especially human beings. The compositions comprise the active ingredient on its own or preferably together with a pharmaceutically acceptable carrier. The dosage of the active ingredient depends on the disease to be treated, and on species, age, weight and individual condition, individual pharmacokinetic conditions, and the mode of administration.

The pharmaceutical compositions may comprise from approximately 1 % to approximately 95 % active ingredient, forms of administration in single dose form preferably comprising from approximately 20 % to approximately 90 % active ingredient and forms of administration that are not in single dose form preferably comprising from approximately 5 % to approximately 20 % active ingredient. Unit dose forms are, for example, dragées, tablets, ampoules, vials, suppositories or capsules. Other forms of administration are, for example, ointments, creams, pastes, foams, tinctures, lipsticks, drops, sprays, dispersions, etc. Examples are capsules comprising from approximately 0.05 g to approximately 1.0 g of the active ingredient.

The pharmaceutical compositions are prepared in a manner known *per se*, for example by means of conventional mixing, granulating, confectioning, dissolving or lyophilising procedures.

Solutions of the active ingredient, and also suspensions or dispersions, especially isotonic aqueous solutions, dispersions or suspensions, are preferably used, it being possible, for example in

the case of lyophilised compositions that contain the active ingredient alone or together with a carrier, for example mannitol, for such solutions, suspensions or dispersions to be made up prior to use. The pharmaceutical compositions may be sterilised and/or may comprise excipients, for example preservatives, stabilisers, wetting agents and/or emulsifiers, solubilisers, salts for regulating the osmotic pressure and/or buffers, and are prepared in a manner known *per se*, for example by means of conventional dissolving or lyophilising procedures. The said solutions or suspensions may comprise viscosity-increasing substances, such as sodium carboxymethylcellulose, dextran, polyvinylpyrrolidone or gelatin.

Suspensions in oil comprise as the oil component the vegetable, synthetic or semi-synthetic oils customary for injection purposes. There may be mentioned as such especially liquid fatty acid esters that contain as acid component a long-chained fatty acid having from 8 to 22, especially from 12 to 22, carbon atoms, for example lauric acid, tridecylic acid, myristic acid, pentadecylic acid, palmitic acid, margaric acid, stearic acid, arachidic acid, behenic acid, or corresponding unsaturated acids, for example oleic acid, elaidic acid, erucic acid, brassidic acid or linoleic acid, if desired with the addition of antioxidants, for example vitamin E, β-carotene or 3,5-di-tert-butyl-4-hydroxytoluene. The alcohol component of those fatty acid esters has a maximum of 6 carbon atoms and is a mono- or poly-hydric, for example a mono-, di- or tri-hydric, alcohol, for example methanol, ethanol, propanol, butanol or pentanol or the isomers thereof, but especially glycol and glycerol. The following examples of fatty acid esters are therefore to be mentioned: ethyl oleate, isopropyl myristate, isopropyl palmitate, "Labrafil M 2375" (polyoxyethylene glycerol trioleate, Gattefossé, Paris), "Labrafil M 1944 CS" (unsaturated polyglycolised glycerides prepared by alcoholysis of apricot kernel oil and consisting of glycerides and polyethylene glycol ester; Gattefossé, France), "Labrasol" (saturated polyglycolised glycerides prepared by alcoholysis of TCM and consisting of glycerides and polyethylene glycol ester; Gattefossé, France) and/or "Miglyol 812" (triglyceride of saturated fatty acids with a chain length of C_8 to C_{12}, Hüls AG, Germany), but especially vegetable oils, such as cottonseed oil, almond oil, olive oil, castor oil, sesame oil, soybean oil and more especially groundnut oil.

The injection compositions are prepared in customary manner under sterile conditions; the same applies also to introducing the compositions into, for example, ampoules or vials and to sealing the containers.

Pharmaceutical compositions for oral administration can be obtained, for example, by combining the active ingredient with one or more solid carriers, if desired granulating a resulting mixture, and processing the mixture or granules, if desired, and if necessary by the addition of additional excipients, to form tablets or dragée cores.

Suitable carriers are especially fillers, such as sugars, for example lactose, saccharose, mannitol or sorbitol, cellulose preparations and/or calcium phosphates, for example tricalcium phosphate or calcium hydrogen phosphate, and also binders, such as starches, for example corn, wheat, rice or potato starch, methylcellulose, hydroxypropylmethylcellulose, sodium carboxymethylcellulose and/or polyvinylpyrrolidone, and/or, if desired, disintegrators, such as the above-mentioned starches, also carboxymethyl starch, crosslinked polyvinylpyrrolidone, or alginic acid or a salt thereof, such as sodium alginate. Additional excipients are especially flow conditioners and lubricants, for example silicic acid, talc, stearic acid or salts thereof, such as magnesium or calcium stearate, and/or polyethylene glycol, or derivatives thereof.

Dragée cores can be provided with suitable, optionally enteric, coatings, there being used *inter alia* concentrated sugar solutions which may contain gum arabic, talc, polyvinylpyrrolidone, polyethylene glycol and/or titanium dioxide, or coating solutions in suitable organic solvents or solvent mixtures, or, for the production of enteric coatings, solutions of suitable cellulose preparations, such as acetylcellulose phthalate or hydroxypropylmethylcellulose phthalate. Colourings or pigments may be added to the tablets or dragée coatings, for example for identification purposes or to indicate different doses of active ingredient.

Orally administrable pharmaceutical compositions also include dry-filled capsules consisting of gelatin, and also soft, sealed capsules consisting of gelatin and a plasticiser, such as glycerol or sorbitol. The dry-filled capsules may contain the active ingredient in the form of granules, for example in admixture with fillers, such as corn starch, binders and/or glidants, such as talc or magnesium stearate, and optionally stabilisers. In soft capsules, the active ingredient is preferably dissolved or suspended in suitable liquid excipients, such as fatty oils, paraffin oil or liquid polyethylene glycols or fatty acid esters of ethylene or propylene glycol, to which stabilisers and detergents, for example of the polyoxyethylene sorbitan fatty acid ester type, may also be added.

Other oral forms of administration are, for example, syrups prepared in customary manner which comprise the active ingredient, for example, in suspended form and in a concentration of about 5 % to 20 %, preferably about 10 %, or in a similar concentration that provides a suitable single dose, for example, when administered in measures of 5 or 10 ml. Also suitable are, for example, powdered or liquid concentrates for the preparation of shakes, for example in milk. Such concentrates may also be packaged in single dose quantities.

Suitable rectally administrable pharmaceutical compositions are, for example, suppositories that consist of a combination of the active ingredient and a suppository base. Suitable suppository bases are, for example, natural or synthetic triglycerides, paraffin hydrocarbons, polyethylene glycols or higher alkanols.

For parenteral administration there are suitable especially aqueous solutions of an active ingredient in water-soluble form, for example in the form of a water-soluble salt, or aqueous injection suspensions that contain viscosity-increasing substances, for example sodium carboxymethylcellulose, sorbitol and/or dextran, and, if desired, stabilisers. The active ingredient, optionally together with excipients, can also be in the form of a lyophilisate and can be made into a solution prior to parenteral administration by the addition of suitable solvents.

The Compounds for use in the invention can be administered, prophylactically or therapeutically, as such or in the form of pharmaceutical compositions, preferably in an amount effective against the said diseases, to a warm-blooded animal, for example a human being, requiring such treatment, the compounds being used especially in the form of pharmaceutical compositions. In such treatment an individual of about 70 kg body weight will be administered a daily dose of from approximately 0.1 g to approximately 5 g, preferably from approximately 0.5 g to approximately 2 g, of a compound of formula I.

The following Examples serve to illustrate the invention and refer to the accompanying Figures, in which

Figure 1 which shows the 30 bp fragment used as a mRNA instability sequence in the reporter gene assay of Example 1;

Figure 2 which shows plasmid diagrams for pGL2_Neo30 and pGL2-Control; and Figure 3 shows graphs of luciferase activity from clones 53 (solid bars) and 63 (open bars) treated with various concentrations of radicicol analog A (SDZ 216-732).

EXAMPLES

Example 1: Reporter Gene Assay for compounds which destabilise mRNA

A. Construction of pGL2_neo30

In order to obtain a vector for stable integration into THP-1 cells a XhoI - SalI fragment of the neo resistant gene derived from pMCIneo (Stratagene) is subcloned into the SalI site of pGL2-Control (Promega). A 30bp fragment obtained by annealing two complementary synthetic oligonucleotides (see Fig 1) is subcloned using the PflM1 restriction site. This 30bp fragment contains three tandem AUUUA motifs based on the IL-Iβ 3'UTR sequence. Modification of pGL2-Control (Promega) by introducing a neomycin resistant marker gene (expressing aminoglycoside 3' phosphotransferase) and by adding 30bp of IL-1β 3UTR sequence results in the luciferase expression vector pGL2_Neo30 (Fig. 2). Fig. 1 shows the IL-1β 3'UTR sequence containing three tandem AUUUA motifs used for ligation into the PflMI site of pGL2-Control.

B. Transfection and selection of stable cell lines

The resulting vector (pGL2_neo30) is cotransfected with pGL2-Control into THP-1 cells by electroporation. 10^7 cells/ml in 1.3mM KH_2P0_4, 7.36m.M Na_2HP0_4, 2.44mM KCl, 124mm NaCl, 5mM glucose, 9.6μM $MgCl_2$ and 16μM $CaCl_2$ pH 7.2 are transfected with 20μg of DNA in a Bio-Rad Gene Pulser (250V, 690μF and indefinite resistance) using a 0.4cm cuvette. Cells are subsequently cultured in RPMI medium containing 10%FBS, 2mM L-Gln (L-glutamine), 50μM 2-mercaptoethanol and 600μg/ml of G418 (geneticin). After transfection of pGL2_Neo30 and pGL2-Control into THP-1 cells, stable cell lines are obtained by selection for G418 resistance and assayed for luciferase activity. One cell line of each transfection is chosen for further analysis; the pGL2_Neo30 cell line is referred to as clone No. 63 and the pGL2-Control cell line as clone No. 53. No endogenous luciferase activity could be detected in normal THP-1 cells.

C. Tissue culture:

The transfected human monocytic leukemia cell lines, clones No. 53 and 63 are grown in RPMI medium supplemented with 110 U/ml penicillin, 100 μg/ml streptomycin, 2 mM L-Gln and 2 g/1 $NaHCO_3$. Heat-treated FBS (5%) is added before use. The cells are grown to a density of 5x

10^5/ml and induced to differentiate with 100 U/ml (final concentration) γIFN. Three hours later, 10 µl of LPS (5µg/ml final concentration) is added. This time point is designated time 0. Compounds are added at various times after LPS addition as indicated.

D. Luciferase activity measurement:

In order to adapt the system to the use of 96 well plates, cells are grown in Packard flat bottom white polystyrene microplates (Cat. No.6005180) in RPM1 medium lacking phenol red (AMIMED). Cells are plated at $5x10^4$/well. After treatment of the cells, luciferase is measured using the Packard Luc Lite system (Cat. No.601691 1) according to the manufacturer's instructions in a final volume of 205µl. Briefly, to a cell suspension of 5 x 10^5 cells/ml, γIFN (1000U/ml Boehringer Mannheim No. 1050494) to a final concentration of 100 U/ml and 0.25% (v/v) Luc Lite Enhancer is added. After a 3 hour incubation LPS (50µg/ml SIGMA L-8274) is added to give 5µg/ml final concentration. The cells are then plated at $5x10^4$/100µl/well into flat bottom white polystyrene microplates (Packard, Cat. No. 6005180) and incubated for 16 hours. 5 µl of compound solution or control vehicle is then added and the cells are further incubated as indicated. 100 µl of luciferase substrate solution is added and the plates are covered with TopSeal-A press-on adhesive sealing film (Packard Cat.No. 6005185) before measuring luminescence with a Packard Top Count Scintillation Counter at 22°C. The luciferase signal is stable for at least 90 min.

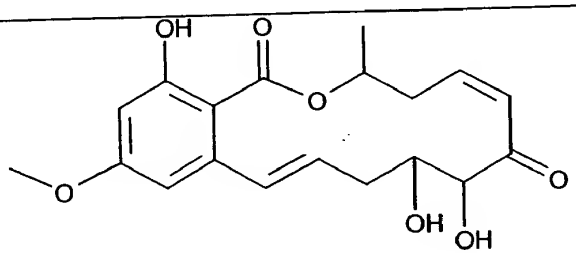
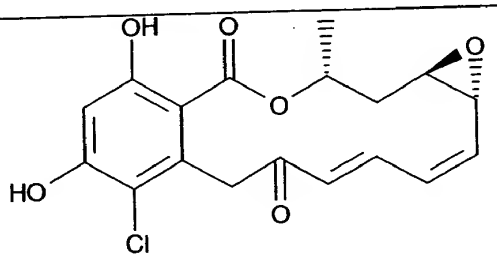
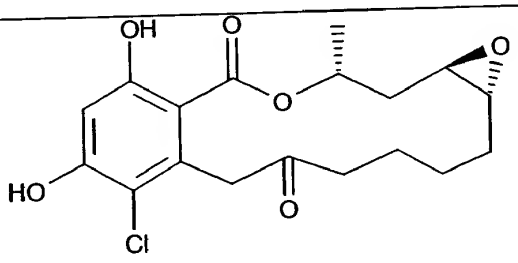
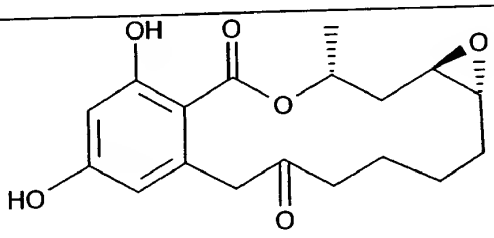
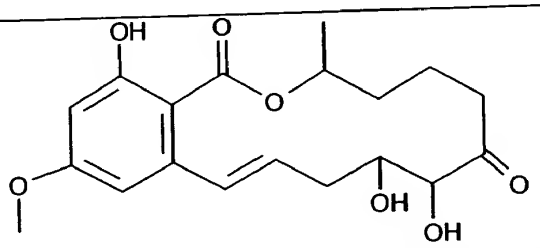
Example 2: Effect of the radicicol analog A

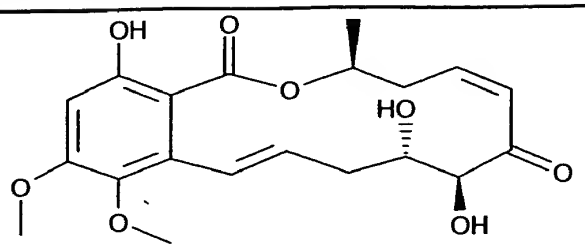
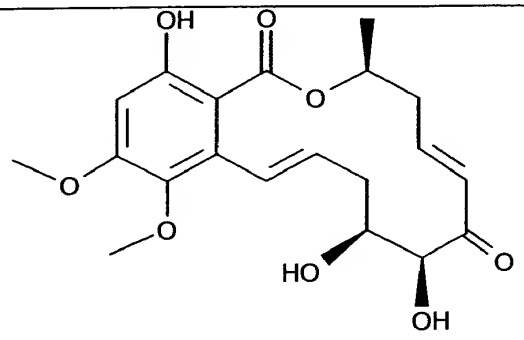
The THP-1 cell lines, clone No. 63 (containing PGL2_Neo30) and clone No. 53 (containing pGL2-Control) are grown, differentiated and stimulated with γIFN and LPS identical to normal THP-1 cells. Radicicol analog A is added 16 hours after the addition of LPS and cell extracts are then taken 8 hours later or as indicated. Luciferase activity is inhibited by 1 µM radicicol analog A on average by 50% +/-17%, in some cases inhibition was as great as 93%, whereas up to $5x10^{-6}$M of radicicol analog A has no effects on the control clone No. 53, Fig. 3 (solid bars indicate clone No. 53, open bars clone No. 63).

Example 3: Application of Reporter Gene Assay to a number of radicicol analogs

A number of radicicol analogues are tested for their activity in the reporter gene assay substantially as described in the previous Examples. The results obtained are given in the Table below.

TABLE

COMPOUND	Luciferase reporter gene assay			
	clone	0.5μM	1μM	5μM
	53	114	105	107
	63	97	88	87
	53	68	51	40
	63	42	18	3
	53	99	77	69
	63	88	64	57
	53	83	81	70
	63	80	66	61
	53	103	122	104
	63	107	93	70

	53	136	140	108
	63	69	32	9
	53	97	91	55
	63	96	94	7

Example 4: Tablets, each comprising e.g. 50 mg of radicicol analog A or a pharmaceutically acceptable salt, are prepared as follows:

Composition (10000 tablets)

active ingredient	500.0 g
lactose	500.0 g
potato starch	352.0 g
gelatin	8.0 g
talc	60.0 g
magnesium stearate	10.0 g
silicon dioxide (highly dispersed)	20.0 g
ethanol	q.s.

The active ingredient is mixed with the lactose and 292 g of potato starch and the mixture is moistened with an ethanolic solution of the gelatin and granulated through a sieve. After drying, the remainder of the potato starch, the magnesium stearate, the talc and the silicon dioxide are mixed in and the mixture is compressed to form tablets, each weighing 145.0 mg and comprising 50.0 mg of active ingredient; the tablets may, if desired, be provided with breaking notches for finer adaptation of the dose.

Example 5: Film-coated tablet, each comprising 100 mg of radicicol analog A or a pharmaceutically acceptable salt are prepared as follows:

Composition (for 1000 film-coated tablets)

active ingredient	100.0 g
lactose	100.0 g
corn starch	70.0 g
talc	60.0 g
calcium stearate	1.5 g
hydroxypropylmethylcellulose	2.36 g
shellac	0.64 g
water	q.s
methylene chloride	q.s.

The active ingredient, the lactose and 40 g of the corn starch are mixed and moistened with a paste prepared from 15 g of corn starch and water (with heating) and granulated. The granules are dried, the remainder of the corn starch, the talcum and the calcium stearate are added and mixed with the granules. The mixture is compressed to form tablets (weight: 280 mg) which are then film-coated with a solution of the hydroxypropylmethylcellulose and the shellac in methylene chloride; final weight of the film-coated tablet: 283 mg.

Example 6: Hard gelatin capsules, comprising 100 mg of active ingredient, for example radicicol analog A or a pharmaceutically acceptable salt are prepared, for example, as follows:

Composition (for 1000 capsules)

active ingredient	100.0 g
lactose	250.0 g
microcrystalline cellulose	30.0 g
sodium lauryl sulfate	2.0 g
magnesium stearate	8.0 g

The sodium lauryl sulfate is added to the lyophilised active ingredient through a sieve of 0.2 mm mesh size. The two components are intimately mixed. Then first the lactose is added through a sieve of 0.6 mm mesh size and then the microcrystalline cellulose is added through a sieve of 0.9 mm mesh size. The mixture is then intimately mixed again for 10 minutes. Finally the magnesium stearate is added through a sieve of 0.8 mm mesh size. After mixing for a further 3 minutes, size 0 hard gelatin capsules are each filled with 390 mg of the resulting formulation. Soft gelatin capsules may be prepared using similar ingredients and procedures.

CLAIMS

1. A compound which induces degradation of mRNA which contains one or more mRNA instability sequences for use as a pharmaceutical, provided the compound is not a radicicol analog.

2. A method for the prophylaxis or treatment of a disease or medical condition having an etiology associated with the increased stability of mRNA which contains one or more mRNA instability sequences, comprising administering to a human or animal patient an effective amount of a compound which induces degradation of the mRNA, provided that the compound is not a radicicol analog when the disease or medical condition is one with an etiology associated with or comprising excessive cytokine release, particularly IL-1β release, such as rheumatoid arthritis, osteoarthritis, septic shock, psoriasis, atherosclerosis, inflammatory bowel disease, Crohn's disease and asthma.

3. Use of a compound which induces degradation of mRNA which contains one or more mRNA instability sequences, for the preparation of a medicament for use in the treatment or prophylaxis of a disease or medical condition having an etiology associated with the increased stability of mRNA which contains one or more mRNA instability sequences, provided that the compound is not a radicicol analog when the disease or medical condition is one with an etiology associated with or comprising excessive cytokine release, particularly IL-1β release, such as rheumatoid arthritis, osteoarthritis, septic shock, psoriasis, atherosclerosis, inflammatory bowel disease, Crohn's disease and asthma.

4. A method for inducing degradation of mRNA in a patient, which comprises administering an effective amount of a compound which induces mRNA degradation to the patient, wherein the mRNA contains an mRNA instability sequence, provided that the compound is not radicicol analog A when the mRNA is mRNA coding for IL-1β, IL–6 or TNF-α.

5. Use of a compound which induces mRNA degradation in the preparation of a medicament for use in inducing degradation of mRNA which contains a mRNA degradation sequence in a

patient, provided that the compound is not radicicol analog A when the mRNA is mRNA coding for IL-1β, IL–6 or TNF-α.

6. All novel compounds, methods and uses substantially as hereinbefore described with particular reference to the description and Examples.

ABSTRACT

ORGANIC COMPOUNDS

Compounds which induces degradation of mRNA which contains one or more mRNA instability sequences are provided for use as pharmaceuticals, e.g. for use in the prophylaxis or treatment of diseases and medical conditions in general having an etiology associated with the increased or prolonged stability of mRNAs which contain one or more mRNA instability sequences, and which on prolonged or inappropriate expression typically give rise to undesirable effects, e.g. cancer cell growth or an unwanted inflammatory response.